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FRACTURES OF THE FEMUR
AND
THEIR TREATMENT.

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The fracture of the os femoris, on account of the proximity of the thigh to the trunk, as well as of the large size of the femoral bone, and also of the indispensable office which the latter performs in locomotion, is to be reckoned among the gravest of injuries: owing to this fact, its minute study has, in modern times, become a subject of emulation and sharp rivalry among the great names that have figured as practitioners of, and writers upon, surgery. Thus it called forth the thought of England's greatest surgeon, Sir Astley Cooper, whose Essay on the Fracture of the Neck of the Thigh Bone will charm every reader of the work entitled Fractures and Dislocations of the Joints, in which book it is now incorporated; not only has the intrinsic merit of this chapter given it a place among medical classics, but its clearness of method and practical character must ever remain an evidence of the talent of this great man and a monument to his genius.

It is perhaps proper that the writer of this dissertation should state, at its commencement, that he intends herein to exclude all consideration of the phenomena exhibited in the reparative processes of fractured bones, and strictly to confine himself to the special surgery of the subject. Furthermore, the ideas contained within this paper are not of theoretical origin, but are the result of his own observations in over one hundred cases of fracture of the thigh-bone that

have fallen under his surgical treatment, partly in private practice but more largely as patients in St. Mary's Hospital, San Francisco, which institution is the leading hospital for accidents, on the Pacific Coast of the United-States of America.

As preface to the surgical part of the subject, we will first notice some of the anatomical features of the femur, which have a bearing on its fracture: its globular head; its constricted neck flattened antero-posteriorly and perforated with a great number of orifices; the superadded trochanteric processes — the greater one with its muscular force pulling the femur outwards, the other being a point to which force, that can flex either the limb or the body, is applied; the foregoing are all dynamic agents directly or indirectly influencing fracture of the femur. For example, the head, inserted air-tight into the innominate bone, becomes thus, as it were, part and parcel of this bone and hence shares with the latter comparative immunity from injury. Between the head, thus protected, and the trochanteric expansion of the shaft, lies, isthmus-like, the neck; the latter is, in youth, tolerably well fortified against either direct or indirect violence, since, in early life, it deviates in direction but slightly from the shaft, while, in later life, it becomes so bent upon the shaft as to approach a right-angle; firstly, from this flexion results hampered vascularity and nutrition interfered with from the constant transit of indirect violence across the neck; secondly, in the aged, the osseus structure having become more porous it has less resisting power; here, then, we have two predisposing causes to the fracture of this bone in old age. Not only does the angular relation of the neck to the shaft break the uniformity in the transmitted violence, but it also causes it to concentrate more at certain points; thus the violence ascending would act more on the upper part of the neck, while, on the contrary, the violence from the acquired impetus of the

body in falling, would act more on the lower section; so thus, again, does angularity predispose to fracture. In the two sexes there is a notable difference in regard to the conformation of the femur: the increased pelvic expansion of the female results in almost rectangular flexion of the femoral neck.

The study of the lines of direction in which is accomplished the muscular function of the adductors, of the ileo-psoas or forward flexor, and of the group of external rotators, will materially assist the surgeon in the solution of the abstruse problem of the position assumed by the limb after its fracture: in all cases the position will be found to be the necessary result of the composition of the forces just enumerated, eliminating, however, such muscles from the calculation as may have been paralyzed by the causal violence. The coxo-femoral capsule, immensely strong in front where it is strengthened by Bertin's ligament, but far weaker behind, must be taken into account in certain fractures of the upper portion of the femur.

Sites of Fracture. The femur may be fractured in its shaft, neck, lower end, and, lastly, either of the two trochanters may be separated; thus named, the fractures stand in order of frequency, that of the shaft being the most common.

We will first take for consideration the fracture of the neck of the os femoris: this fracture may be wholly inside of the articular capsule, in which case the line of detachment may approach a transverse direction; or, the line of fracture may commence inside and, running obliquely, may pass through the attached insertion of the capsule and end extra-capsular; and, lastly, the upper fragment may be caused to glide, cap-like, over the pointed end of the lower fragment thus constituting impaction. The symptoms in each case are similar; viz., there is shortening of the limb with outward rotation, that is, the foot is everted; the

trochanter major is moved from its normal place, being lifted upwards and outwards so that it is unnaturally prominent. The amount of shortening is influenced by the direction of fracture; for example, it is greater where the direction is oblique, it is much less where the direction is transverse, and, finally, if there is impaction, the shortening is often so slight that great skill in the admeasurement of the limbs is required to detect any difference in their length. Crepitus is a general accompaniment of this fracture. By means of the diagnostic points just given, the surgeon can, as a rule, readily determine the character of the injury. There are cases, however, where the diagnosis is not so obvious; for instance, eversion of the limb may be absent, and crepitus likewise if the case is one of impaction; even where crepitus exists the normal sensation and sound yielded by it, may be muffled by the thick muscular mass beneath which the fragments are buried; in such a case the double-tubed stethoscope used in the United States of America, becomes a valuable aid in detecting the sound. There is, however, a crepitus sometimes heard in luxation when the femoral head is caused to move against the innominate bone; but this latter crepitus is not heard at the same site where that of fracture is heard, and the sound from luxation is more prolonged than that from the broken neck, of which the sound is shorter and sharper. Fracture of the femoral neck occurs only in persons of advanced years. Hence, in brief, shortening of the limb, eversion of the foot and crepitus heard near the coxo-femoral joint, found in the old subject, afford almost certain evidence of the existence of fracture in the neck of the femur.

Causes. This fracture may arise from direct or from indirect violence; nearly akin to the latter head is muscular contraction. A blow upon the trochanter major, or falling and striking upon this point, may sever the head

of the femur from its shaft. In jumping from a height, when the descending body is arrested by the striking of the feet upon the ground, the momentum of the body suspended on and between the femoral necks, tends to continue onwards, and thus fracture may take place on whichever side receives the greater part of the shock. In the case supposed, one can readily see how the fractured end of the shaft would pass upwards and outwards, while the broken end of the neck would pass downwards and inwards; thus the capsule would be ruptured and spitted, as it were, upon the sharp or ragged ends. The same may arise from muscular violence. While the aged subject is walking, running, or, especially, ascending steps, (hence the cognomen, curb-stone fracture,) should the foot slip backwards, trip, or be caught, then, as the ileo-psoas becomes stretched like a tight cord from the pelvis to the lesser trochanter, the gluteal muscles being likewise in a similar state of tension, the sudden action of the dorsal erector muscles to rescue the falling trunk, could detach the shaft from its neck. In a similar way, if the toe be caught as the body is advancing, then the strong and unyielding ileo-femoral (Bertin's) ligament would favor a like fracture of the femoral neck. Excessive abduction of the leg, as where the limbs slip asunder, may also break the bone at this point.

The shortening, where the fracture is wholly intra-capsular, varies from one-half an inch to one inch; in this case the capsule, if not opened, confines the broken ends in such a way that they cannot pass much beyond each other; but, if it is partially ruptured, the ileo-psoas and still more the gluteal muscles, will then draw the shaft upwards and outwards; thus the shortening is increased and the greater trochanter becomes more prominent. Where the fracture is partly intra- and partly extra-capsular and very oblique, the conditions are such as to favor a very

considerable degree of shortening which may even exceed two inches; but when the shortening does not exceed one inch it is safe to infer that the fracture is wholly intra-capsular.

The displacement of the shaft in oblique fracture will vary according as the line of fracture passes from without inwards, or from within outwards; in the former case the neck, with the attached trochanter minor, will thrust the shaft outwards, but, in the latter case, with the attached trochanter major, it will thrust the shaft inwards. As before said, fracture of the femur is almost always accompanied by eversion or outward rotation of the leg; this is the case whether the bone is broken through its neck when all the femoral muscles are able to act upon the shaft, or where the injury is near the condyles whereby the distal fragment is placed beyond the sphere of those muscles whose action is usually invoked to explain eversion: hence we must infer that eversion occurs, in some cases, independent of muscular action.

It has been reserved for the ever ingenions and talented Hyrtl to discover that the axis of rotation of the thigh does not correspond to the axis of the femur, but lies internal to that line; thus the greater mass of matter lying outside of this line, tends to roll the leg outwards when abandoned to its own weight; this accords with the common observation of every one that, in swooning, sleep, and death, the limb when unacted upon by any muscular force whatever, always rolls outwards, doing so in obedience to the common law of gravitation. Unfortunately, this eversion is not universal; in a small number of cases observed, the foot did not turn outwards, and in such instances there is danger that the surgeon may commit the serious error of mistaking the case for one of luxation; on the other hand, in luxation of the femur the inversion that, as a rule, characterizes the injury, is wanting in at least

one species. Hence, though most valuable symptoms, inversion and eversion cannot always be relied upon; other conditions must co-exist to render the diagnosis decisive. For example, in the prae-cotyloid luxation where the foot is not inverted, the leg is lengthened, the trochanter is depressed and, often, the head of the femur can be felt on the pubic bone — all being conditions which distinguish the case from one of fracture. Again, if a fracture is accompanied by the anomaly of inversion, the facility with which, by traction. the shortened limb can be restored to its natural length, together with the accompanying crepitus, will enable to distinguish the case from one of luxation. Besides the explanation just given of the anomalous inversion, others have been offered by surgical writers: viz., many have referred it to the direction of the fracture, the bones being so placed in respect to each other that eversion becomes impossible. In such cases as those described by Guthrie and other writers, may not the muscularity of the inside of the limb have been abnormally developed so that, left to itself, the limb would necessarily fall inwards? also, if muscular action be allowed to figure in the phenomenon, may not the gluteal rotators have been paralyzed by the fall so that the adductors were left without antagonism and hence drew the limb inwards?

Prognosis. The prognosis of fracture of the neck of the femur varies exceedingly according to whether the injury is wholly inside the capsule or not: when entirely intra-capsular, the recovery is most difficult and, in many cases, ends in ligamentous union; the explanation is the defective supply of blood to the part, since, the femoral head being separated from the shaft, it is almost isolated from the vascular system; the only vessel from which it can derive any reparative material being that to the ligamentum teres; but, according to Hyrtl's researches, this vessel does not penetrate the bone but, after reaching it,

returns again; hence, like that of the cornea, the nutrition of the detached femoral head is limited to a scanty serous transudation; so from this side of the fracture no proper reparative process can take place, the ossific restoration being limited wholly to the shaft. Non-union was formerly so frequent an occurrence that, among the old surgical writers, the advice was found not to attempt union; more recent authorities advise that some effort be made aiming at union, yet, in terms usually intermingled with so many misgivings that no one under their guidance would act with much zeal or hope. There have, however, been a sufficient number of cures with bony union, to justify the surgeon in resolutely aiming at such a result; and it is the more incumbent on him to do so since, if the subject is left with an un-united fracture, he is hopelessly crippled; a condition wretched and pitiable in the extreme and adding greatly to the discomforts of waning age. Therefore, in all cases where the vital powers have not been exhausted, it is the imperative duty of the surgeon to spare no pains in carrying out a course of treatment having, as its object, bony union. It is probable that in almost no instance is the surrounding capsule left perfectly intact; the fallen patient in whom such fracture has just occurred, is pretty sure to try to rise to his feet and thus the fractured ends can become entangled in the adjacent capsule, and, remaining so, the consequent adhesions may form a bridge of transit for nutrient matter to the upper fragment. Besides this circumstance favorable to repair, if the bones are so adjusted that the broken surfaces fit well upon each other, then the callus forming about the broken end of the shaft can reach upwards and grasp the neck and thus restore bony continuity. The possibility and even probability that one of the contingencies enumerated may be present, is sufficient to stimulate the surgeon, as above said, to neglect no means at his disposal looking towards a cure by bony union.

To avoid repetition, inasmuch as the same modes of treatment are applicable to the different fractures of the femur, we will now, before proceeding to the subject of treatment, briefly notice fractures of the shaft.

Fractures of the femoral diaphysis may arise either from direct or from indirect causes; in the former, the violence acts immediately upon the thigh; in the latter, it may be transmitted from the trunk above or from the leg below. In the United States the accident occurs the most frequently to men whose avocations expose them to entanglement in machinery. The line of fracture may be transverse but more often it is oblique in direction; viz., from above and behind, downwards and forwards. When the fracture is in the upper third of the bone, the strong muscles inserted into the trochanteric prominences, are at once given unrestricted control over the upper fragment while the distal portion of the bone is pulled upwards and backwards by the biceps and adductors. Hence arise extensive displacement and change of figure resulting in loss of the normal anatomical form of the front surface of the limb; there is likewise present a degree of shortening much greater than when the fracture is at the neck of the bone. The diagnostic hints already given in regard to fracture of the neck of the femur, are of equal import in determining fracture of the shaft. The accessibility of every part of the shaft, except that near the knee, to manual examination, renders the diagnosis of fracture a comparatively easy matter in almost every case; difficulty arises only where the soft parts are greatly swollen; where the injury is near the knee, fracture can generally be detected by the crepitus which is perceptible to the hand and audible to the ear by the stethoscope; confirmatory evidence of the same can be obtained by the surgeon firmly grasping the suspected site of injury, while his assistant makes a lateral movement of the leg below; in doing this

a fractured limb can be made to describe a larger arc than an unfractured one.

To retain the fractured ends in constant contact, is more difficult in the shaft than in the neck of the bone, because here strong muscular force acts upon both portions instead of upon but one, as in fracture of the neck. However, according to Pott, an old English authority, the real seat of the deviation is in the lower or posterior portion; that is, the upper part retains its normal site while the lower part sinks or falls backwards; he further adds that in our aims at fixation and co-aptation, it is worse than useless to attempt to rectify the displacement by pressure on the upper fragment, but the correction should rather be made by lifting the distal fragment to its proper place.

Prognosis. In almost all cases, under proper treatment, the limb can be restored to its previous functional usefulness. The exceptions occur where important vessels or nerves are wounded; also where, from the entanglement of the soft parts between the fractured ends, it is impossible to secure proper coaptation of the broken ends and hence pseudarthrosis ensues.

Treatment. The chief office of the leg being that of locomotion, in order that its function in this particular may remain unperverted, it must be of the same length as its fellow; this condition, of less importence in the upper extremity, is indispensable in the lower one. Hence the surgeon has a more important task to perform in the present case; not only must the bone be united but it must be restored to nearly its former length. To be more definite, I will explain what I imply by nearly; in all cases where union can be effected, there is no excuse for the defect being more than one-half inch; nor, if the case be treated properly and often examined, will the defect equal a half-inch; in case, however, that the defect is this

much, the apparent subsequent elongation of the leg through the tilting of the pelvis, will compensate for, and practically remedy, the defect; but if the shortening exceeds this amount then the patient is left with an imperfect limb for life. To prevent this shortening, surgeons have not been idle, nor has their ingenuity been unfruitful of invention and device; if proof of this were needed, the numerous plates of splints which adorn modern works on surgery, are ample evidence. On each one has been inscribed Eureka, and this inscription has remained on it until transferred to its successor. In reviewing these appliances and attempting to classify them, three modes of treatment may be thence deduced: first, that of the double inclined plane; second, the gypsum dressing; third, that of the extending and counter-extending splint.

The cardinal characteristic of the first method, is maintenance of the limb in a constantly flexed position, and, for this purpose, numerous modifications of the inclined plane have been resorted to. For reasons presently apparent it is unnecessary to enter into any minute details of the mechanical contrivance of this apparatus. In favor of the mode of treatment by flexion, it is claimed that, the thigh and leg being on opposite sides of a double inclined plane they thus balance each other, and the action of the muscles of the upper leg is thus counterpoised, and extension of the thigh is thereby secured. But is the leg an exact counterpoise of the thigh? weighed in the scales, the former would, I suspect, be found wanting; and even were the two, exact counterpoises of each other, whence would come the force that is needed to draw asunder the fragments of the femur? Likewise it is asserted that the disturbing femoral muscles are rendered incapable of much action by reason of the flexion of the thigh upon the trunk; but these muscles are inserted mainly upon the upper part of the femur which lies at the beginning of the plane, the

slight elevation of which at that point can exercise but slight influence upon the muscles; furthermore, as these muscles have a constant amount of contractile power in them, if this be excluded from lifting the fragment through the first part of the arc of elevation will it also be excluded from the remaining part of the arc? Is it not more logical to infer that the muscular power acting with undivided energy, might cause more displacement than if the limb were extended in a right line? It is claimed besides that there is less anchylosis of the knee left by this plan of treatment than by that of extension. Yet the anchylosis that does occur is coupled with some angularity, a condition of limb more unfavorable to locomotion than if the leg were straight. It is likewise evident that the numerical and structural superiority of the flexors over the extensors, will enable the former to overcome anchylosis conjoined with extension more readily than the extensors can overcome anchylosis coupled with flexion. Hence, examined critically, the arguments for the double inclined plane are, on this ground, unsatisfactory. Again it is claimed that the condition of flexion is more comfortable to the patient; this is a difficult question to decide, yet, I imagine, were the choice left to the patient, that whichever he should choose he would soon wish he had selected the other. To decide the question we might carry it to the Court of the Ancient Order of Knight Templars who, for punishment of offenders, constructed a cell of such dimensions that in no position was it possible to straighten the limbs at full length. If additional evidence be required to convince of the impropriety of this course of treatment, there is also to be cited the silent protestations of the numerous thigh-bones which the double inclined plane has transformed into semi-lunar curves, and of the thick-soled boots, canes and crutches — the numerous offspring of this treatment.

A second mode of treatment of this fracture is that

known as the gypsum bandage. This plan of treatment I observe is in general use in the hospitals of Germany, and seems particularly applicable to the treatment of said injury in children. In France and England, on the contrary, it is not used. Some five years ago it was introduced into Bellevue Hospital, the leading hospital for accidents in New York City; although the Profession there are somewhat divided in opinion in regard to its use, yet the results thus far speak most favorably in its behalf.

The third mode of treatment may be designated in short as the extending and counter-extending plan. The germ of this mode of treatment may be found among the early classical writers upon medicine, particularly in Celsus in his chapter concerning the treatment of fractures of the extremities; therein, although in language somewhat vague, is found allusion to a method of this kind in vogue in the times of the Caesars. There are two modes of applying extension, one by means of a weight and pulley, the other by the so-called extending and counter-extending splint. I prefer the splint, though the other method is in very common use, and in the hospitals of Edinburgh and London I have observed a number of patients in process of treatment by the weight and pulley.

When called to a case of broken femur the surgeon should first adjust the fracture as nearly as possible and then give directions for the bringing of the patient to the place where he is to remain during treatment, and in carrying him, care must be taken that the injury be not increased by incautious movement; for example, in lifting him from the ground or by jolting of the vehicle, the fractured ends may be thrust into the soft parts and thus vessels and nerves be severed; hence, in raising him from the ground let one person grasp the limb at the site of fracture while the leg is borne by a second person; thus lifted, if he be near his room he can be carried most easily

upon a plank or a stretcher if the latter be at hand. Next, let directions be given about the bed on which the patient is to lie; an iron bedstead is the best, but if this cannot be procured a firm wooden one may be used; upon this a hair mattress should be placed, or if this cannot be obtained one stuffed with straw will answer the purpose; in either case the mattress should be so constructed that a transverse section of it can be withdrawn when the patient's bowels move; thus the vessel can be placed under him without deranging the fracture; the bed being thus arranged the patient is now to be placed upon it; if it is decided to treat the case by extension and counter extension, for which the writer has an especial preference, the surgeon has next to procure a splint adapted to the carrying out of these indications. The various forms of apparatus that have been employed for this purpose are either models or modifications of the so-called splint of Desault. If, as may happen in private practice, the surgeon be not supplied with such an apparatus, the following is a form which can easily be constructed by any mechanic who may be at hand: first a board of pine or other light but firm wood should be obtained, somewhat less than half-an-inch in thickness and, according to the size of the limb, from four to ten inches in width; the splint is composed of two pieces united together; one, a long part that shall reach from ten inches beyond the foot to mid-way between the iliac crest and the arm-pit; the other, a short part which is to be fastened to the lower end of the first, and both must be of the same thickness and width; the short piece must be perforated with two holes two inches apart and situated laterally opposite to each other; if the foot-piece is nailed to the longer piece then, to fix it more firmly, a small block may be nailed in the angle between the two. The long piece should also have holes laterally opposite and two inches apart, corresponding to the iliac crest;

a series of such may be made so as to fit the splint to different cases. Next prepare twelve strips of adhesive plaster (emplastrum plumbi adhaesivi) two feet long and three inches wide; also a like number of strips of the same width but only one foot long; lastly a few cotton rollers and a quarter of a pound of cotton wadding.

These things being in readiness the surgeon proceeds to re-adjust the fracture if need be, and then to apply the splint so as to retain the limb at normal length and in proper position; to adjust, let an assistant grasp the foot and slowly but firmly extend the limb; while this is being done the surgeon should place his hands about the site of fracture and bring the broken ends into as accurate co-aptation as possible; simple traction in a right line and coupled with a slight eversion of the foot, suffices, in most cases, to place the fractured ends in proper relation with each other. If there be great difficulty in accomplishing the adjustment, the patient may be put under the influence of an anaesthetic; if, however, the co-aptation can be accomplished without the aid of the anaesthetic, it is preferable to do so, since the intoxicating influence of the latter often leaves the patient for a time in an irrational, ungovernable state in which, by his disorderly movements, either the soft parts are in danger of being lacerated by the sharp ends of the bones, or, if the limb is already dressed, such movements may derange it. After co-aptation next apply on each side of the leg three long adhesive strips so attached as to reach six inches beyond the foot; the ends are to be tied in a knot close to the sole; next, on the front of the leg on a line corresponding with the femoral vessels, and also behind on a line with the sciatic nerve, apply the remaining strips, viz., three before and three behind: these strips we have supposed to be twenty-four inches long, but in a large subject they should be longer so that when applied the upper free or unattached

end may be at last ten inches long and these free ends are to be twisted into a cord-like form. Next apply half of the short pieces transversely above the ankle so as to firmly fix the strips which have been applied there, and in like manner let the remainder be applied; next bandage the limb from the toes to the groin; while the strips and the roller are being applied, the limb, should be retained in extension by one or more assistants. Next place the splint on the outside of the limb the foot-piece being a few inches beyond the sole, interposing, meanwhile, cotton wadding between the splint and the limb wherever any bony prominences may be endangered by pressure. Next through the noose at the sole, pass a short extending cord and then, through the holes in the upper end of the splint pass the coiled counter-extending strips and tie them together; now pass the ends of the extending cord through the foot-piece and then having drawn the foot out fully to the length of its fellow, tie the cord outside of the foot-piece. To prevent pressure upon the outside and the inside of the foot, from the adhesive plaster, let a wooden block be interposed so as to hold the cords asunder: for this purpose a small section of a shingle may be used. Besides having the limb of proper length, displacement of periphery must likewise be avoided: the foot must be placed at a proper degree of eversion but, in this respect, there is more danger of having an excess than a defect of eversion. From neglect of this precaution I have seen recovery of limbs which were of proper length, injured by the limb being allowed to turn too much outwards during the period of reunion; to prevent this, make a hole through the long splint beyond the foot-piece, through which a cord may be passed and tied; then one end of the cord may be fastened to one side of the foot of the bed, the other end to the other side; thus secured, lateral deviation of the limb cannot occur. Next, at distances of ten inches

from each other, strips or portions of a roller should be passed under the limb and tied, thus including both limb and splint. Lastly, around the body and the upper end of the splint, let a roller or broad bandage be passed making a few turns: thus fastened, the splint is fixed more securely and, what is more, the patient cannot raise the upper part of his body, as many are apt to do when unrestrained. The dressing being now completed, if the patient be restless or suffer pain, give to an adult one-third of a grain of sulphate of morphia; if the pain be not controlled let the dose be repeated in four hours.

Instead of such a foot-piece as here described, it may be movable and so made as to slide in a groove of the long splint, and then be moved back and forth by means of a screw; or, being fixed, the foot-piece may be traversed through its middle by a long screw and then, the extending cord being fastened to this screw, by turning the latter, extension can be made at pleasure. These latter forms are preferable to that first described, but when not to be obtained the other may be used; I have thought proper to describe the first because it is so simple in construction that there is no place where the surgeon could not readily have it made.

If it be objected that the adhesive plaster can not always be procured, it may be answered that even this is not indispensable, since by means of a band passed around the upper part of the thigh and in contact with the perinaeum, the splint may be fastened above and extension can be obtained at the lower end by means of an attachment to the ankle; in fact, until recently, the splint was always applied to the limb in this manner. For the perineal band a large handkerchief or, what is better, a soft towel may be folded into a cord-like form and, to render it still softer, a small quantity of cotton wadding may be folded within. The ends of this band are next

passed through the holes in the upper part of the splint and then tied together. For counter-extension let a broad circular band be put around the ankle, to which band lateral extending straps are to be attached. These straps being passed through the foot-piece, are to be tied tightly after the limb has been drawn out to its proper length. The disadvantages of the ankle- and perineal-bands are that the pressure from them in subjects of delicate texture and especially where it becomes necessary to apply much force, will finally produce serious abrasion of the surface. This abrasion is often present ere the surgeon is aware of it, since the compression of the sentient cutaneous nerves acts as an anaesthetic, and, when discovered by the dresser, the patient himself wonders how such a breach of surface could have arisen without his knowledge. If the bands be well invested with or filled with cotton or wool, the tendency to abrasion will be lessened: yet, despite this, some excoriation at the perinaeum will result from the pressure no matter what kind of a band be used.

To avoid the lesions mentioned from pressure, over twenty years ago Dr. Dixi Crosby an American surgeon, resorted to the use of adhesive strips to form the extending band, and, since that time, the old appliance for the ankle has fallen into disuse in the United States. In 1865 in a case of fractured femur in a subject of remarkable softness of tissue and where a well-made perineal band had produced a frightful laceration of the cruro-perineal fold, I was forced to abandon the ordinary means and, in seeking for a substitute, made trial for the first time of adhesive plaster applied after the mode above described in the text. The results obtained were so favorable that I soon afterwards wholly abandoned the perineal band using the adhesive plaster in its stead; and now, after having used it in every variety of femoral fracture, am prepared to give it an unqualified recommendation.

When the adhesive plaster is of good quality it may retain its hold so firmly that the limb will not require re-dressing for some weeks. The yellow plaster is much better than the white on account of adhering more firmly; yet it should be stated that the permanence of adhesion does not depend wholly upon the plaster since the disposition of the patient to perspire, has an important influence in the matter; for as the plaster prevents the escape of the perspiration, the accumulation of the latter beneath, must finally result in the detachment of the plaster. Of course when thus loosened, the dressing must be renewed being re-applied according to the details already given.

As elsewhere mentioned, the objection sometimes urged against the treatment of the limb in a straight direction, is that the limb is left partly anchylosed; but this mal-position is not inevitable as we always have a remedy which if properly used will reduce the anchylosis to a tolerable minimum; this is passive motion. This must be practised with care and if the surgeon has had but little experience it is much better that in its employment he have the assistance of another surgeon. To practise passive motion, first untie the extending cord and also the strips encircling the limb and splint; next let the assistant grasp the thigh about the site of fracture so that he can hold it securely, and then the surgeon is slowly to flex the knee at least half a dozen times. This should be repeated once a week during the period of treatment. In this manner I have secured recovery with but a slight amount of stiff-ness at the knee, and this disappeared soon after the patient began to use his limb.

The period of time necessary to secure bony union, varies from eight to twelve weeks: in the young adult union is usually completed in eight weeks; in those over forty years, at least ten weeks should be allowed; and for the old and feeble three months is often required.

A very important caution to be borne in mind is, that though union has apparently taken place, yet, in cases where the callus is extensive, owing to the bone having been broken into several pieces, a much longer period of rest should be enjoined than where the fracture is simple: where this rule is neglected, early locomotion is apt to be followed by a gradual bending of that portion of the shaft enveloped in callus. In a few cases of excellent recovery I have seen the limb subsequently shorten in consequence of the patient's premature attempts at locomotion.

And how should locomotion be commenced? The first essays are best made upon crutches; when the patient has acquired confidence he may be allowed a cane; after a short time the latter also may be dispensed with.

Where it is decided to treat the fracture by means of a weight and pulley, then a bed must be prepared similar to that used with the long splint. At the foot of the bed an upright piece bearing a pulley must be fastened; next, with adhesive strips, a cord is to be fastened to the foot in a manner similar to that described for extension with the long splint; this cord is next passed over the pulley and attached to a weight destined to maintain extension. This may be of iron, stone, or any substance of which the weight is known. For children from four to six pounds' weight suffices, but for adults, from twelve to fifteen pounds must be used; the criterion in all cases being that a weight must be used sufficient to maintain the injured limb at proper length. Finally, to prevent the body from sliding downwards, let the foot of the bed be elevated somewhat higher than the head: thus the body of the patient will act as a counter-extending force. To prevent anchylosis, passive motion as above described should be practised from time to time.

Along with fractures of the diaphysis may be reckoned those of the condyloid extremity of the femur. But as

these are more grave and complicated in character than the former, I have thought best to reserve their consideration for a separate section of this dissertation.

The condyloid extremity may be detached in toto from the shaft, or both condyles may be detached separately from the shaft, or one alone may be broken off.

Where the condyloid end is separated in mass from the shaft, the resulting displacement is apt to be very considerable and of a character extremely hard to correct. This displacement occurs in obedience to the following muscular forces, viz., the gastrocnemial heads pull the condyloid end downwards and backwards, while the adductors and extensors unite in lifting the broken shaft forwards. Such a displacement as this is extremely difficult to overcome and in spite of the best efforts of the surgeon, pseudarthrosis may ensue. To treat such a case after the adhesive strips have been applied, the limb should be accurately bandaged from the foot to the groin and then extended as already described. To carry out the advice of Pott, elsewhere given, a sustaining cushion should be applied so as to support the lower fragment.

Contrary to the advice given in reference to re-dressing the fractured shaft, in this fracture the dressing should be frequently renewed. Thus proceeding, the surgeon will find that at the successive dressings he can gradually correct the displacement; in the end he will have the satisfaction of gaining the ascendant if his vigilance has had more endurance than the refractory muscles. Passive motion should not be attempted under three weeks, and then the leg should only be flexed through a small arc; for if much motion be practised, the coalescing fragments will be separated and the foundation laid for a false joint.

The fracture may involve one or both condyles, and in such case the joint is seriously compromised, since one or both crucial ligaments are implicated. In fact the

injury becomes one of great gravity inasmuch as recovery cannot occur without some anchylosis, and although this cannot destroy, it must impair the future use of, the joint.

For treatment of fracture involving one or both condyles, let the limb be well bandaged from the foot to the body; should there be shortening, the long extending splint must be used; but as there is often little or no shortening, it suffices then after the limb is bandaged, to retain it at rest by means of two long sand-bags placed one on each side.

But whether the surgeon decides to employ the splint or the sand-bags for the maintenance of rest, he should constantly bear in mind that the time for obviating or reducing the anchylosis to the smallest limits, is during the period of healing. The passive motion should be commenced early after the fracture and repeated at least once in every two days, provided always that the joint be not much inflamed; this task is a difficult one, and there is danger that the surgeon may accede to the patient's entreaties and thus fall short of what is possible in the way of cure. But he should recollect that the most rational sympathy is that which does not circumscribe its vision to the transitory pains of the present but takes in a more comprehensive view of the patient's future. An early resort to passive motion is attended with the beneficial results that thus we prevent the formation of, or thrust aside, the reparative ossific matter from between the articular surfaces of the joint and so obviate the first conditions of anchylosis.

If it be objected that this passive motion and also the subsequent voluntary motion, would prevent ossific union with the condyles of the shaft, the answer is that though fibrous union may result, it will in no wise interfere with the articular function of the part; further, the modicum of movement that such fibrous tissue would permit, added

to the limited movements of the joint, would tend to enlarge rather than limit its sphere of action.

Fracture of the Trochanters. Fracture of the trochanter major may arise from direct violence, as from a heavy blow. the kick of a horse, etc. This injury when isolated and unconnected with lesion of the adjacent joint, is less grave in character than other fractures of the femur; but if the joint be simultaneously implicated, the case becomes one of much greater gravity. If a part or the entirety of the trochanter be detached from the shaft, then the gluteal muscles would lift the fragment upwards and outwards; the displacement, however, is not always easily recognized since the extensive contusion and accompanying ecchymosis, along with the thick muscularity of well-formed subjects, are serious obstacles in the way of verifying the condition of the parts.

Fracture of the smaller trochanter has rarely been seen. One cannot conceive of its occurring otherwise than from violent action of the ileo-psoas muscle; the detachment having thus occurred, contractility of the muscle would be given unlimited sway, so that the fragment would be drawn upwards towards the groin in a position where it could be felt.

Treatment. In fracture of the great trochanter, the chief thing to be aimed at, is to counteract the action of the gluteal muscles; for this purpose the limb should be everted and extended; to maintain the leg thus, it may be fixed between two sand-bags reaching from the foot to the middle of the thigh. Where the lesser trochanter is fractured, the patient should be placed in bed with the limb resting upon a cushioned inclined plane, the foot being raised through an arc of at least thirty degrees; the foot should be placed in eversion. Not less than eight weeks should be allowed for the cure of either fracture.

Pseudarthrosis or non-union following fracture of

the femur. — Sometimes it occurs that from defective treatment, or from the absence of any treatment, or, finally from the want of reparative effort on the part of nature, imperfect union ensues. In such case the fractured ends are either united by a tendinous structure, or large masses of callus may form; the latter from the limb not having been retained at rest, results in the formation of two articular surfaces admitting of more or less motion; the latter mode of union more especially deserves the cognomen of pseudarthrosis or false joint.

For the cure of pseudarthrosis many plans of treatment have been proposed, among which the following may be mentioned as the principal: rubbing the ends of the bones together, a plan suggested by Celsus; passing a seton through the soft parts between the fractured ends; (Physick;) resection with union by means of ivory pegs, by which the ends are literally nailed together; (Dieffenbach;) boring through the fractured ends with the view to excite an ossific inflammation; (Brainard;) and lastly resection and subsequent union by means of silver wire. The latter method was used as early as 1855 by the late Elias S. Cooper, surgeon of San Francisco, U. S. A.; from that time until his death in 1861 he successfully used it for the treatment of a large number of cases of pseudarthrosis. Cooper's method, somewhat resembling that of Dieffenbach, consisted in cutting down upon the fractured ends, dissecting away the intervening fibrous tissue, next sawing off the ends of the bones in such a manner that they would fit upon each other, the ends thus apposed being then bored through and a silver wire passed through them; finally the two ends of the wire were firmly twisted together, a splint being afterwards applied to the limb and the case subsequently treated like any wound.

Besides a number of cases of pseudarthrosis of the humerus, the fore-arm, and the tibia, successfully treated

by Cooper's method, I have also treated two of the femur. The first case was one where the false joint was at the middle of the shaft and arose from the fracture having been very oblique as well as from the muscles upon the one side having been so transfixed by the spear-like fragment that co-aptation was impossible. At the end of six months, there being no union, I was consulted by the patient and advised the metallic ligature. The operation consisted in making an incision upon the outer side of the limb at a point which would favor the free escape of pus during the future healing process. The fractured ends when exposed were found to be united merely by fibrous tissue which was carefully dissected away; next the obliquely fractured surfaces were applied to each other, a hole drilled through them through which a wire was passed and so twisted as to retain the ends firmly in contact. The traumatic fever resulting from the operation, was very severe for a number of days and placed the patient's life in extreme jeopardy; this, however, finally subsided and without further trouble the case slowly proceeded to a recovery completed at the end of about four months. During treatment the limb was maintained both at rest and in extension by means of a long lateral splint.

In the second case the man had already lost one leg and, there being no necessity for co-equal length, the surgeon in attendance seemed to have abandoned the fractured limb wholly to the efforts of nature, as, according to the patient's statement, no extension whatever had been practiced. The result was, gliding and mounting of the broken ends upon each other and the formation of immense masses of callus which finally ended by assuming a hinge-like disposition, the one end loosely interlocking with the other. This fracture was at the union of the middle and lower third of the bone. The limb had been twelve months in this condition when the man applied to me for surgical

treatment. On examination I found that the false joint admitted of nearly as much movement as did the knee. The only means of locomotion was creeping, infant-like, upon the floor; for, as the man had lost the other limb by amputation the existence of a false joint in the remaining leg, rendered it impossible for him to move in any other way than by crawling.

Having found by experience in the treatment of several cases of pseudarthrosis of the humerus and tibia, that a much simpler treatment than that above described answered equally well, I determined to try it in this case; it was as follows: On the outside of the lower or distal fragment, the bone was reached by means of a small incision; next, a drill was applied at this point and directed obliquely both upwards and inwards so as to traverse both bones, emerging at a point sufficiently high to not endanger the femoral vessels; as soon as the point of the drill could be felt a small incision was made down upon it; a strong silver wire was then made to traverse the drilled canal and then to return over the upper part of the bone to the point of entrance where the ends were united by being twisted together; to return the wire over the bone, a large blunt needle was used. In cases of the tibia and humerus where no such needle was at hand, I have found the common silver probe with an eye at one end, to answer equally well. After the wire was fastened, a number of canals were drilled into the fractured ends; finally, to fix the limb at rest, a long splint was applied to it on the outside. No febrile re-action and but slight pain, followed the operation. Union occurred at the end of four months, and at the end of six months after the operation, the patient, by the aid of an artificial limb upon the other leg, was able to walk, if not gracefully, at least very satisfactorily to himself.

VITA.

The following biographical sketch of the author of the foregoing Dissertation, in compliance with custom here, is appended:

He was born and received his early education in Ohio, United States; received the Medical doctorate from Jefferson College, Philadelphia; was commissioned in 1856, a member of the surgical Corps of the U. S. Navy, after an examination in which the position of number one of candidates examined was assigned him, and more recently, he was admitted a Member of the Royal College of Surgeons, London; and now, as he is on the eve of being invested with the doctorate from Friedrich-Wilhelms-University, he begs leave to thank Professors Virchow, Langenbeck and Frerichs for the courtesies received from their hands, and especially for the ideas learned from their teaching.

THESES.

1. Ad membranam in faucibus e diphtheria ortam amovendam adhibitio, alcoholis localis remedium potens est.

2. Ossis fractura in obliqua pseudarthroseos causa solita est.

3. Urethrotomia externa in perineo potius quam dilatatio violenta in strictura admodum angusta optanda est.